Technology Opportunity

Lightweight Nickel Electrodes

The National Aeronautical and Space Administration (NASA) Lewis Research Center developed a lightweight nickel fiber electrode to replace the state-of-the-art heavy sintered nickel electrode for nickel-based systems.

Potential Commercial Uses

Nonmilitary

- Electric vehicle
- Portable equipment
- Commercial batteries

Space and Military

- Communication satellites
- Exploratory rovers
- Soldier systems

Benefits

- Improves cell mass by a factor of 2
- Extends lifetime by 5 years
- Improves performance
- Good for all nickel-based systems

The Technology

The nickel electrode is currently the specific-energy-limiting component in any nickel-based battery system, including nickel-hydrogen, nickel-cadmium, nickel-zinc, and nickel-metal hydride. Such battery systems are important in a multitude of commercial, aerospace, and military applications. Nickel-hydrogen (Ni-H_2) batteries are used extensively in aerospace systems because of their relatively high specific energy and energy density and their excellent cycling capabilities. For the past several years, NASA Lewis Research Center has been developing Ni-H_2 cells. The overall objective of the program is to improve the components, design, and operating characteristics of the cell. In most applications, the weight and size of the components are of extreme importance. It is, therefore, essential to reduce the weight of these components as much as possible. Table 1 shows the weight distribution of a typical 50 A-hr Ni-H_2 cell. The nickel electrode accounts for 38 percent of the cell weight.

For many years, the state-of-the-art (SOA) heavy-sintered nickel powder plaque has been the substrate of choice to support the electrochemically active material in these nickel-based batteries. The nickel powder plaque accounts for a considerable portion of the weight of the electrodes. NASA Lewis initiated a program to decrease the electrode weight by using lightweight nickel plaques. Lewis, in collaboration with Hughes Aircraft Company and Auburn University, is currently developing and testing lightweight nickel electrodes made from commercial

Table 1. Weight distribution of a 50 A-hr Ni-H_2 cell using an SOA nickel electrode

Component	Weight	
	g	%
Nickel electrode	513	38
Hydrogen electrode	76	6
Separator	47	4
Electrolyte	206	15
Pressure vessel	249	19
Miscellaneous	245	18
Total cell weight	1336	100

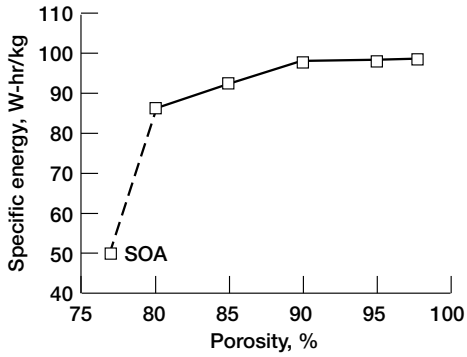

Figure 1.—Effect of porosity in 50 A-hr Ni-H_2 cell.

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nickel fiber plaques (Memtec America Corp. and Ribbon Technology Corp.). These plaques are lighter in weight and have smaller fiber diameters than the heavy-sintered nickel powder plaques. One advantage of using smaller nickel fibers is the significant increase in the surface area available for deposition of the active material, as well as the increase in the electrochemical accessibility to the active material. Porosity and thickness are two important variables to be considered in the evaluation of the nickel plaques; these variables affect the specific energy, performance, and cycle life of the battery. An advantage that the lightweight fiber plaques have over the SOA heavy-sintered nickel powder plaques is that they can be easily manufactured with much larger porosities. Lightweight plaques are commercially available in porosities up to 98 percent, whereas commercial SOA sintered plaques are available in porosities of 75 to 85 percent. The specific energy of a Ni-H_2 cell will increase by replacing the sintered nickel electrode with the highly porous lightweight nickel fiber electrode. For example, the specific energy of a 50 A-hr Ni-H_2 cell (see fig. 1) increases from 50 W-hr/kg to 100 W-hr/kg if a SOA nickel electrode is replaced with a lightweight nickel fiber electrode. The specific energy of the Ni-H_2 cell improves with increasing porosity. Initial cycling and performance tests of the nickel fiber electrodes are very promising.

Options for Commercialization

A patent on this innovation is pending. Development of lightweight nickel fiber electrodes for nickel-based batteries with high specific energy has significant commercial importance. Such batteries are useful in any application where savings in weight are crucial. Potential commercial applications include electric vehicles, portable electrical equipment such as lap top computers, cellular phones, and hand-held tools.

Contact

Doris L. Britton
Mail Stop 309-1
NASA Lewis Research Center
Cleveland, OH 44135
Phone: (216) 433-5246
Fax: (216) 433-6160
E-mail: Doris.L.Britton@lerc.nasa.gov

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